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A North Dakota Geology Field Trip Primer

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Guide to the Vertebrate Paleontology of the High Plains – The Late Mesozoic–Cenozoic Record of North Dakota

Joseph H. Hartman, editor

A preliminary version of this guide was issued to the participants of the October 2003 field trip by the same name, conducted under the auspices of the Society of Vertebrate Paleontology prior to its annual meeting.

UND GEOLOGY

A North Dakota Geology Field Trip Primer

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Introduction

The rocks containing vertebrate fossils in North Dakota represent an important archive of biological and geological events that took place from around 80 million years ago to the present (Figure 1). Although the record is not complete through this interval of time, significant exposures provide important sections of Earth's geologic history (Figure 2). We continue to understand better how seas moved back and forth across North Dakota and the life that persisted in these seas and adjacent estuaries. The terrestrial habitats and river drainages that are recorded in nonmarine strata contain important insights into the patterns of dinosaur diversity up to the end of the Cretaceous followed by the adaptive radiation of mammals across the Cretaceous–Tertiary (K/T) boundary. North Dakota preserves aspects of K/T extinction drama quite well in its badland topography. This event is followed by a succession of isolated vertebrate local faunas throughout the Paleogene and into the early Neogene. Vertebrates are, of course, not the only fossil resource of North Dakota, but they are the subject of this field trip volume.

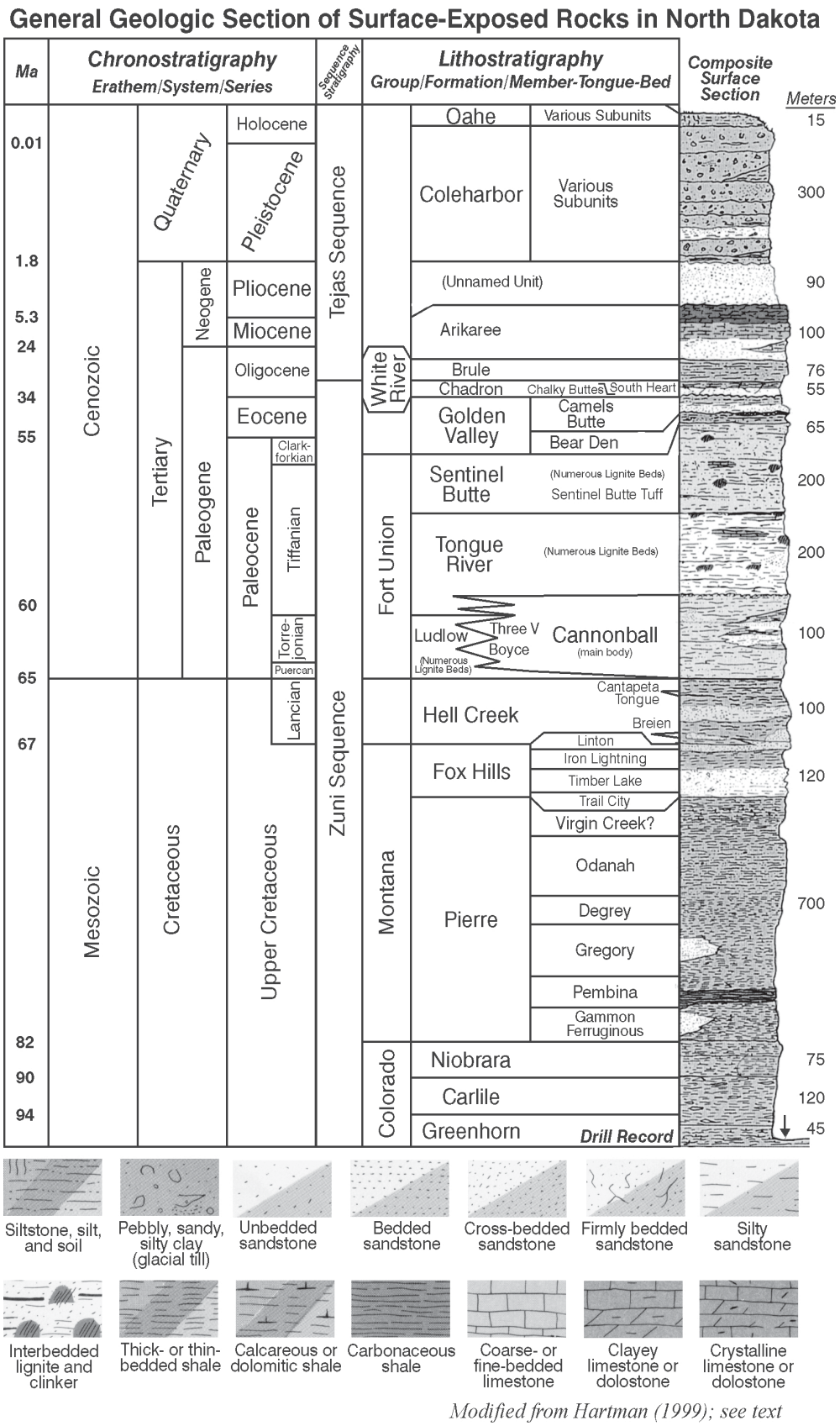
These fossils are brought to life, in part, by visiting fossil localities and enjoying the thrill of discovery as reported by those who found or worked these digs or by you in visiting these localities for the first time (Figure 3). This field trip volume is the result of a guidebook organized for the participants of the October 2003 premeeting field trip of the Society of Vertebrate Paleontology (SVP) Annual Convention (St. Paul, Minnesota). To make the contributions of the authors of this volume more widely available, a revised version was thought appropriate. To permit a reduced cost and include color images, an electronic format was thought to be most effective.

Acknowledgments

The authors wish to thank the reviewers Jonathan Bloch of the South Dakota School of Mines and Technology and John Storer of the Yukon Governmentfor their insightful remarks on the manuscripts. I also wish to thank Victoria Swift and Jane Russell for their comments on the manuscript, John McCauley for his production help with electronic media, and Roy Beard for his long-term facilitation of my electronic goals.

In aiding the successful undertaking of the field trip, I wish to gratefully acknowledge the support and assistance of the administration and staff of the Department of Geology and Geological Engineering (GGE) and Energy & Environmental Research Center (EERC) of the University of North Dakota, the North Dakota Geological Survey (NDGS), and the Pioneer Trails Regional Museum. In addition, information provided by the following agencies is very much appreciated: the University of North Dakota Alumni Association and Foundation, Greater Grand Forks Visitor Center, North Dakota Department of Tourism Division, the Minnesota Geological Survey (MGS), and Minnesota Department of Transportation.

For their many considerations, I would specifically like to thank Connie Larson and Richard



Modified from Hartman (1999); see text

Figure 1. General geologic section of surface-exposed rocks in North Dakota.

Figure 2. View north from the Painted Canyon Overlook of clinkers and other well-layered beds of the upper Paleocene Sentinel Butte Member of the Fort Union Formation in Theodore Roosevelt National Park (Hartman photo C11960).

LeFever (GGE); John Harju and Trish Belker (EERC); Julie LeFever, Kent Hollands, and John Bluemle (NDGS); Ken Harris (MGS); and Debbie Pederson (The Sherwood Group for SVP). For their patience and good cheer in assisting in copying and collating the guidebook, I also wishes to thank Bud and Mardi Holland and Anne Bakken of Grand Forks.

Fossil Localities and Collecting

A locality that has not been worked for a while may easily be overlooked. One of the Judson sites appears to be just another road intersection, and another graded and grassed hill (see Kihm and Hartman, this volume). Listening to presenters tell the history of the various fossil localities creates a unique virtual hands-on experience. With a little imagination, the cold October sunrise experienced by our SVP field trip participants becomes a "dig," with plenty of sweat and hardy effort.

Those nonpaleontologists who read these contributions on-site and have the opportunity to visit these fossil localities may gain some taste of field trip experience. All in all, paleontology is enjoyed most by doing, and it is hard to beat doing it in the field.

Whether the weather conditions are fair or foul, there are always discoveries to be made and stories to tell (Figure 4).

While visiting a fossil locality, there are some important topics to consider that paleontologists take seriously, such as vertebrate fossil collecting. There are two basic rules to follow in visiting a locality mentioned in this volume: 1) Virtually all land is owned by someone and permission is absolutely necessary to access private property and 2) Vertebrate fossils on federal and state lands require a permit to collect. In keeping with the first rule, if you have to cross a fence, it's probably private and you need permission from a landowner. If access is unfenced, the land may be either private or managed, but if federal or state the public can visit but not collect vertebrate fossils. For more information on permits and procedures in North Dakota, view the North Dakota Geological Survey's Web site at www.state.nd.us/ndgs/paleoregs/Paleoreg.htm orcontact John Hoganson(see Table 1).

Figure 3.Fossils are where you find them, but they are easier to find at some places more than others. Here, Phil Gensler, Hagerman of Fossil Beds National Monument, Hagerman, Idaho, finds vertebrate fossils relatively common in the Chadron Formation at the Little Badlands Proper Site. This is one of North Dakota's designated Natural Areas, recognized for both its scenic beauty and paleontological value (Hartman photo C11899).

Figure 4.John Hunter, a field trip coleader, points to the K/T boundary event horizon at Mud Buttes, as others look on and photo document (Hoganson photo).

The SVP Field Trip

The SVP field trip was conducted on October 12–14, 2003, out of St. Paul, Minnesota, and traversed nearly 1600 miles (2575 km). Three vans reached the southwestern corner of North Dakota and were within a mile (2 km) of Montana, near Beach (Figures 5a and 5b). To accommodate the miles and the short time frame, many meals were eaten in the vans. The weather cooperated with only a light sprinkle the night of the second day. A list of leaders, facilitators, and participants are as follows (Table 1).

The field trip route is shown in the maps in Figures 5, 6, 9–11, 15, 18. Making for a long day, we left St. Paul, Minnesota, at about 7:15 a.m., had lunch in Fargo, North Dakota, and visited our first stop, the Hell Creek Formation Stumpf Site in the midafternoon (Figures 5a, 6a, and 6b). Although we lacked the long daylight hours of summer, we still managed a few beautiful late afternoon hours touring the Stumpf Site Natural Area (see Hoganson, this volume, and Figure 7). We finished Day 1 by visiting the collections and exhibitions (Figure 8) of the age Center of the State of Historical Society of North Dakota in Bismarck (www.state.nd.us/hist/hcenter.htm).

Table 1

Field Trip Leaders	
Joseph Hartman	University of North Dakota, Grand Forks
John Hoganson	North Dakota Geological Survey, Bismarck
John Hunter	New York Institute of Technology, Old Westbury
Allen Kihm	Minot State University, Minot, North Dakota
Dean Pearson	Pioneer Trails Regional Museum, Bowman, North Dakota
Student Facilitators and Presenters	
Karew Schumaker	Minot State University, Minot, North Dakota
Georgia Knauss	University of Iowa, Department of Geosciences, Iowa City
Participants	
Arvid Aase	Fossil Butte National Monument, Kemmerer, Wyoming
John Alroy	University of California, Santa Barbara
Richard Baer	Lathrup Village, Michigan
David Chopp	Oconomowoc, Wisconsin
Christian Cicimurri	Clemson University, Clemson, South Carolina
David Cicimurri	Clemson University, Clemson, South Carolina
William Clemens	Museum of Paleontology, University of California, Berkeley
Stephen Cumbaa	Canadian Museum of Nature, Ottawa, Ontario
Philip Currie	Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta
Kevin Dermody	State Museum of Pennsylvania, Carlisle
Eric Dewar	University of Massachusetts, Amherst
Dougal Dixon	Boyds Mills Press, Dorset, United Kingdom
Masato Fujita	Board of Education of Ohyama Town, Toyama, Japan
Bill Gallagher	New Jersey State Museum, Trenton
Phil Gensler	Hagerman Fossil Beds National Monument, Hagerman, Idaho
Jon Graff	San Jose, California
Naoki Ikegami	Mifune Dinosaur Museum, Kumamoto Pref., Japan
Eva Koppelhus	Royal Tyrrell Museum of Paleontology, Drumheller, Alberta
Mona Marsovsky	Alberta Palaeontological Society, Calgary
Vaclav Marsovsky	Alberta Palaeontological Society, Calgary
Bevin O'Grady	Rutgers University, Camden, New Jersey
John Pappas	Rutgers University, Camden, New Jersey
Kenneth Stadtman	Brigham Young University, Provo, Utah
John Strong	Anza-Borrego Desert State Park, Corona Del Mar, California
Yukimitsu Tomida	National Science Museum Department of Geology, Tokyo,
Wighart von Koenigswald	Institut für Palaeontologie, Bonn, Germany

Day 2 was also a full day of driving and stops. At dawn, we were at one of the late Paleocene Judson localities (see Kihm and Hartman) (Figures 5a and 9), southeast of New Salem. The two northern localities, more or less opposite each other, have been graded over and seeded and have not been field worked for many years. The southern localities are still, more or less, natural exposures, typical of the rolling plains, blowouts, and roadcuts common throughout west-central North Dakota. No sign of the trenching that occurred here remains. Because of the lack of continuous outcrop, interpreting the stratigraphic placement of fossil localities throughout this area is very difficult. One is aided in the placement of fossil occurrences, however, by organizing them within the context of lignite and silcrete beds, which can be correlated to temporally important fossil local faunas.

The next stop was in the Little Badlands south of South Heart (see Hoganson), southwest of Dickinson (Figure 10a), which includes some of the youngest strata reported in this volume. The brisk,

Figure 7. The uppermost Cretaceous Hell Creek ormation Stumpf Site is also a North Dakota Natural Area, preserving one of the most complete Hell Creek sections in the Missouri River trench and good exposures of the marine Breien Member. Here, John Hoganson, coleader, discusses the history of the designation of Natural Areas in North Dakota (Philip Currie photo 1674).

Figure 8. An excellent mount of *Plioplatecarpus*, a mosasaur and major marine predator in Late Cretaceous seas of North Dakota, is on exhibit at the Heritage Center on the State capitol grounds in Bismarck (Hartman photo C11881).

northwesterly winds offset the bright sunshine for the clothing challenged (especially the reporter the came out to visit us). The hike into the Natural Area (see photos) resulted in a number of new fossils of the Oligocene White River Group for the State paleontological collections. With limited time today, we drove by the Fitterer Ranch Site (Figure 10b), but discussed its study history and paleontology with radio communication (at least part of the time) between the vehicles.

After picking up bag lunches at the Pioneer Trails Regional Museum (Figure 11a), we drove west to Rhame across Paleocene strata (see Figure 1) and then south to the Mud Buttes localities (Figure 11b) (see Pearson, this volume). This area is rightly famous for its many paleontological studies based on carefully collected and stratigraphically well-controlled plants, vertebrates, and mollusks. The geologic section is represented by the Hell Creek Formation and Fort Union Group and contains well documented K/T boundary sections (Figure 4). Besides the geologic significance of the wonderful geology preserved in this area, the stark beauty of the Hell Creek mudstone is offset by banded layers of other lithologies and the silcrete rubble that is strewn across the valley floor.

Figure 14.There is something different about a group of paleontologists as people. They will come to a cold and rather bitter hill top to see a minor pit dug in the ground, a blowout, or minor exposure just to see where really cool, very small fossil vertebrate fossils are being found. Here, Allen Kihm, trip coleader, and student facilitator, Karew Schumaker provide the history and current study of the Medicine Pole Hills local fauna. On a slightly warmer, less windy late afternoon, this view towards South Dakota and Montana across grazing bison would seem quite remarkable (Hoganson photo).

With cold winds, the day turned more bitter as we crossed through the bison pastures and up the slopes of the Medicine Pole Hills (Figure 11b) to the fabulously rich vertebrate fossil locality of the same name (see Kihm, this volume). The late afternoon sun did little to warm the winds chaffing us on the hill top. Nonetheless, the distant view into the breaks of the Little Missouri River to the southwest, virtually to the corner of the state, was certainly enjoyed by the more warmly dressed (Figure 12). The evening's festivities were hosted by the Pioneer Trails Regional Museum (see Pearson, 1999; and www.ptrm.org) and the people of Bowman. The regional collections and exhibits (Figures 13, 14) were explained and available for us to view and discuss into the late hours.

Figure 15. At the Pioneer Trails Regional Museum (PTRM), Phil Currie of the Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, takes the opportunity to examine fossil matter on hand, a time-honored tradition among vertebrate colleagues (Hartman photo C11938).

Figure 16.Besides the fossils they have collected in the southwestern part of North Dakota, the PTRM staff have also placed on exhibit the diversity of life found in the marine and nonmarine strata spanning essentially all of the bedrock section found in the state. Here, *Triceratops* saunters by (Philip Currie photo 1733).

The third day began with concerns over the obvious small rain puddles that had formed after most of us had turned in. Calls to ranchers the north had assured us that the dirt roads were as bone dry as ever. We breakfasted at PTRM and waited for the sun to rise. We drove west to Rhame and on to Marmarth, crossing the National Wild and Scenic Little Missouri River. Marmarth has seen busier days as a major Milwaukee Road switching yard, but it has been a fine place from which to headquarter field studies and share an evening's repast with colleagues and locals. Just west of Marmarth, we turned on to a gravel road that alternates between various road bed materials and native substrate as it meanders its way towards Golva (Figure 15a). This road has been much improved over the last couple of decades, but, if the rains soak the road here and there, it is as impassable as ever. We made an unplanned photo stop at Pretty Butte (Figure 16). When the sun is out, the south and southeast views of this clinker-capped Hell Creek–Ludlow section provide clear reason for the name applied to this butte. We drove north and turned east

at the first obvious intersection (Figure 15b). The next stop was at the dissected badlands of the "School Section Creek" on the Brown Ranch and U.S. Forest Service property (checkerboard pattern of ownerhsip throughout this area). This drainage has been studied by many (see Hunter and Hartman, this volume, and references therein) and is one of the main areas preserving macrofossils of the Boyce and Three V Tongues of the Cannonball Formation. We hiked through the sage and well-known rattlesnake country to an overlook down the tributaries to the Little Missouri River for our morning presentation (Figure 17).

Figure 17. Pretty Butte is a well-recognized landmark on the west side of the Little Missouri River. Slightly better lighting and the butte could have more lived up to its name. The section in Hell Creek and Ludlow strata, capped by clinker (Hartman photo C11948).

Figure 18. The Brown Ranch presentation was held overlooking "School Creek Section" and the Little Missouri River. Here, Joseph Hartman, trip leader helps carry the discussion to the movement of the Paleocene seas, which are well represented in this area (Hoganson photo).

The guidebook route takes us back towards Montana and north to Golva (Figure 18a). From there, we lose our few moments of hardtop road and turn east back towards the Little Missouri River where we pick up West River Road. This very scenic drive through the relatively deep river valley provides a good view of the Tongue River Member, capped by the Sentinel Butte Formation. Teddy Roosevelt also followed this route on his first bison hunt in 1883, as he headed south out of Little Missouri (Medora was then under construction) (Hartman, 1993) (Figure 18b). We made our final geological stop at the Painted Canyon Overlook (Figure 19) at the Theodore Roosevelt National Park just north of Interstate I-94. The lighting was good, and the stop made for a final save-the-best-for-last kind of impression. The badlands of the park and adjacent wilderness area are part of the finely dissected drainage of the Little Missouri River. The rocks from the overlook are of the Sentinel Butte Member of the Fort Union Formation and include clinker beds of baked clay that add spectacular highlights (Figure 20). St. Paul was now a long way off. Another, more elaborate, preplanned supper was eaten on the road as night closed in around us. The team leading the trip did not park the vans at the rental agency and sit in a comfortable chair until well past 2:00 a.m.

Some Terminology

The terms site, locality, and local fauna are used in this report and may deserve some explanation to the general reader. The terms site and locality are frequently used by authors with their own specific consistent intent. MacIntyre (1966) defined them to have specific paleontological meaning (Table 2).

Table 2

Term	Definition
Locality	A part of an area, with stated geographic limits, usually about one-quarter or one-eighth of a square mile (122–61 m^2) in size, yielding fossils from given beds within a formation.
Site	An accurately designated part of a locality usually about 100 feet (30 m) square, yielding fossils from essentially the same level.
Local Fauna	A term used to represent a collection of fossils from a stratum (bed) or few contiguous strata (layers of rock) of limited thickness over a very limited geographic area with the intent of representing a natural assemblage or community of living organisms.
Faunule Florule	Terms synonymous with local fauna, but applying to animals and plants, respectively.
Fauna/Flora	Terms referring to an entire population, not restricted to a single locality or horizon, of an area, stratigraphic interval, or time interval.
NALMA	The North American Land Mammal Age system represents a time or temporal framework based on the evolutionary history of mammals. Specific ages/stages (e.g., Puercan, Pu) can be subdivided into subunits (Pu1 NALMA).

MacIntyre's intent with these definitions is a good one and grew out of an earlier habit of generalized references to collecting locations. A site was to add precision to an otherwise general collected specimen locality. As times have changed and individuals have only collected with community analysis in mind, the term locality has frequently been employed synonymously with site as used by MacIntyre, and site restricted to even finer levels along a contiguous stratum. In any case, the author's individual intent should be clear from use. The four Judson Sites/ Localities for example, are all precisely known by stratum and geographic collecting area. They were grouped together by Holtzman (1978) as the Judson Locality in the presumption that they represented a MacIntyre-type collecting area defined by a restricted stratigraphic interval and geographic area. In a temporal way, this is undoubtedly true, but depositionally there are differences in the sedimentology and molluscan faunules of different sites. The Stumpf Site is a good example of a collecting area (see Hoganson, this volume), not a specific stratum or geographic location in the sense of MacIntyre. Thus, although consistent use of simple terms would be preferred, the meaning should be clear from the context used by the author.

Figures 19–20.Same basic view as in Figure 2, but by other photographers and shown here to capture the variation in badlands perspective by the viewer, the camera, and the film. The view is north from the Painted Canyon Overlook in Theodore Roosevelt National Park.

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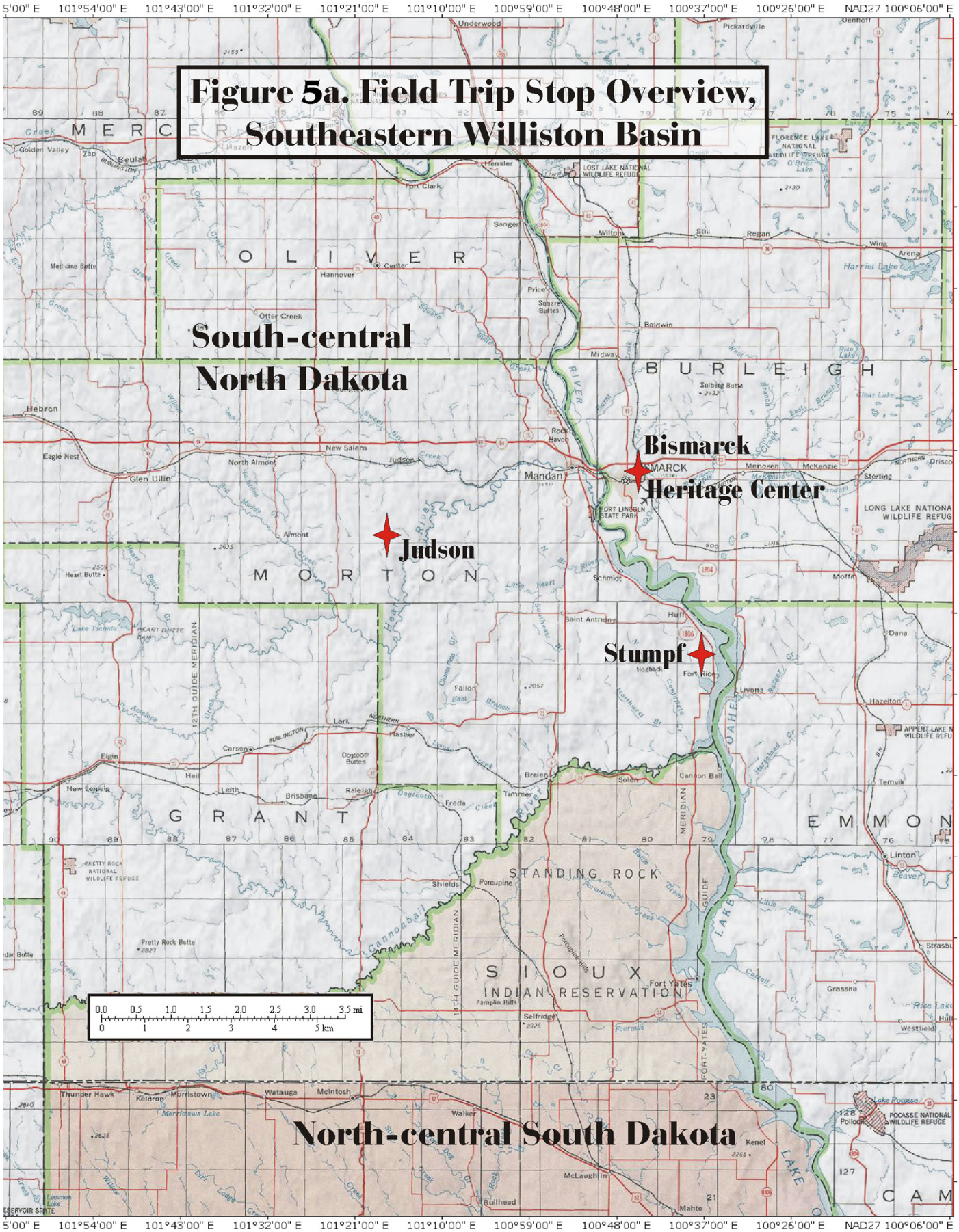
Figure 5a. Field Trip Stop Overview, Southeastern Williston Basin
South-central North Dakota
Bismarck
Heritage Center
Judson
Stumpf
North-central South Dakota
MERCER
OLIVER
MORTON
GRANT
BURLEIGH
EMMON
STANDING ROCK
SIOUX
INDIAN RESERVATION
Mandan
Hebron
New Salem
Glen Ullin
Hannover
Center
Underwood
Hensler
Fort Clark
Wilton
Regan
Baldwin
Harriet Lake
Solberg Butte
Rock Haven
Menoken
McKenzie
Sterling
Almont
Heart Butte
Schmidt
Moffit
Saint Anthony
Huff
Dana
Livona
Hazelton
Carson
Elgin
New Leipzig
Leith
Brisbane
Raleigh
Freda
Timmer
Brelen
Solen
Cannon Ball
Temvik
Linton
Shields
Porcupine
Pretty Rock Butte
Fort Yates
Grassna
Strasbu
Westfield
Selfridge
Pamplin Hills
Thunder Hawk
Kelsron
Morristown
Watauga
McIntosh
Walker
Kenel
McLaughlin
Bullhead
Mahto
Pollock
Lake Pocasse
POCASSE NATIONAL WILDLIFE REFUGE
LONG LAKE NATIONAL WILDLIFE REFUG
APPERT LAKE N WILDLIFE REFU
FLORENCE LAKE NATIONAL WILDLIFE REFUGE
LOST LAKE NATIONAL WILDLIFE REFUGE
PRETTY ROCK NATIONAL WILDLIFE REFUGE
FORT LINCOLN STATE PARK
12TH GUIDE MERIDIAN
10TH GUIDE MERIDIAN
FORT-YATES
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 mi
0 1 2 3 4 5 km
5'00" E
101°54'00" E
101°43'00" E
101°32'00" E
101°21'00" E
101°10'00" E
100°59'00" E
100°48'00" E
100°37'00" E
100°26'00" E
NAD27 100°06'00" E
47°19'00" N
47°12'00" N
47°05'00" N
46°58'00" N
46°51'00" N
46°44'00" N
46°37'00" N
46°30'00" N
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45°55'00" N
45°48'00" N

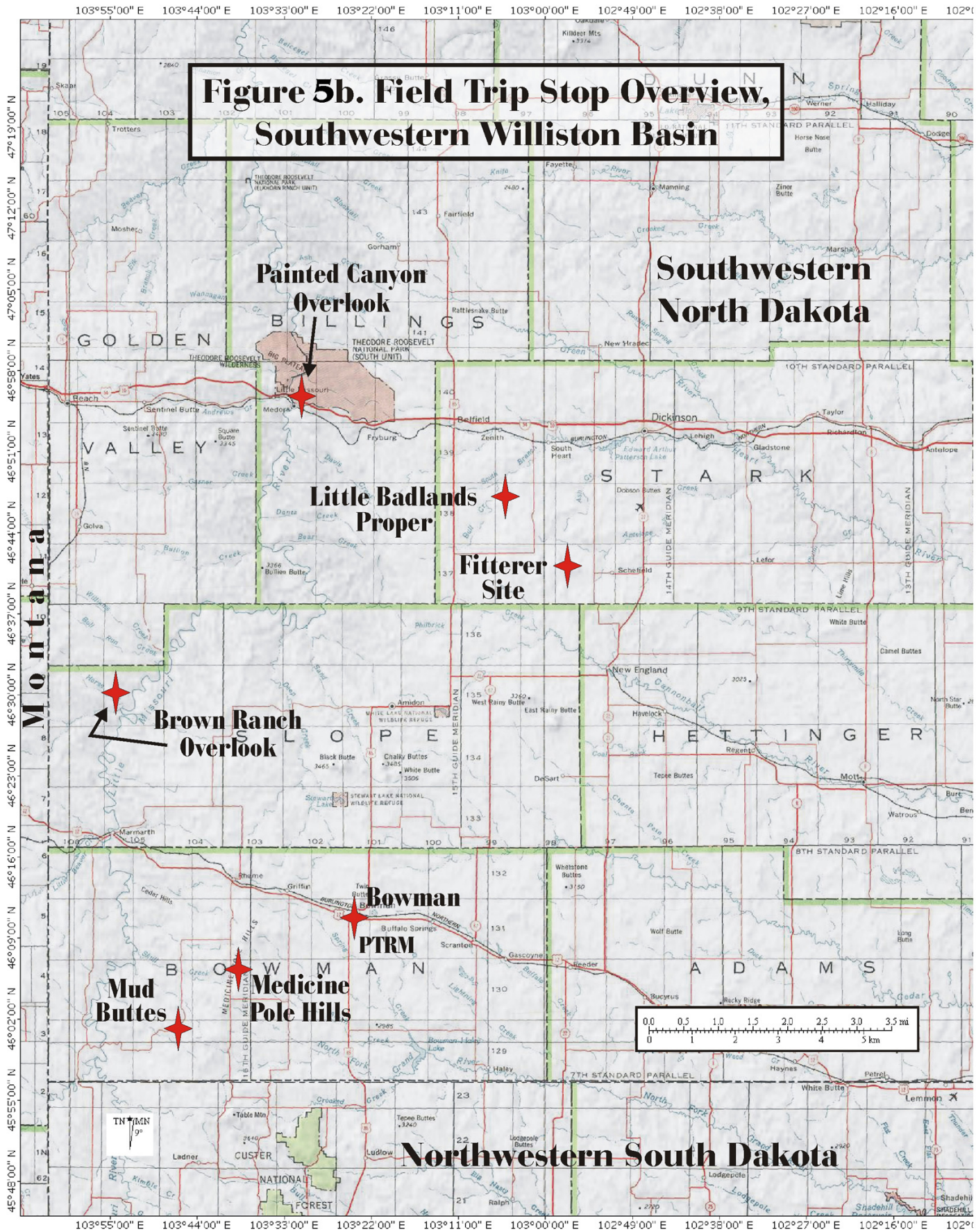
Figure 5b. Field Trip Stop Overview,
Southwestern Williston Basin
Painted Canyon Overlook
Southwestern North Dakota
Little Badlands Proper
Fitterer Site
Brown Ranch Overlook
Bowman
PTRM
Mud Buttes
Medicine Pole Hills
Northwestern South Dakota
Montana
GOLDEN VALLEY
BILLINGS
STARK
SLOPE
HETTINGER
BOWMAN
ADAMS
DUNN
THEODORE ROOSEVELT NATIONAL PARK (SOUTH UNIT)
THEODORE ROOSEVELT WILDERNESS
CUSTER NATIONAL FOREST
10TH STANDARD PARALLEL
9TH STANDARD PARALLEL
8TH STANDARD PARALLEL
7TH STANDARD PARALLEL
14TH GUIDE MERIDIAN
15TH GUIDE MERIDIAN
16TH GUIDE MERIDIAN
13TH GUIDE MERIDIAN
103°55'00" E
103°44'00" E
103°33'00" E
103°22'00" E
103°11'00" E
103°00'00" E
102°49'00" E
102°38'00" E
102°27'00" E
102°16'00" E
47°19'00" N
47°12'00" N
47°05'00" N
46°58'00" N
46°51'00" N
46°44'00" N
46°37'00" N
46°30'00" N
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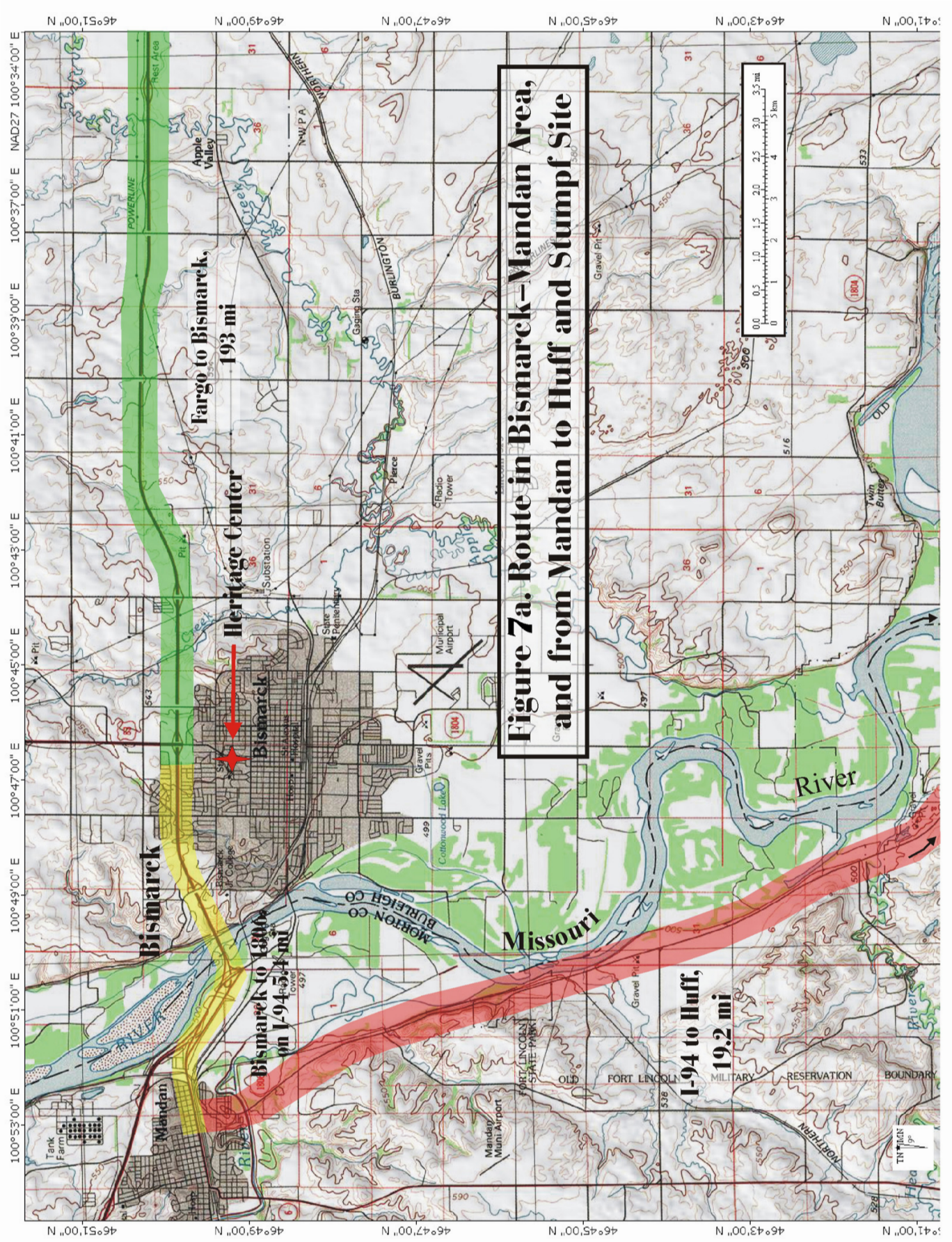
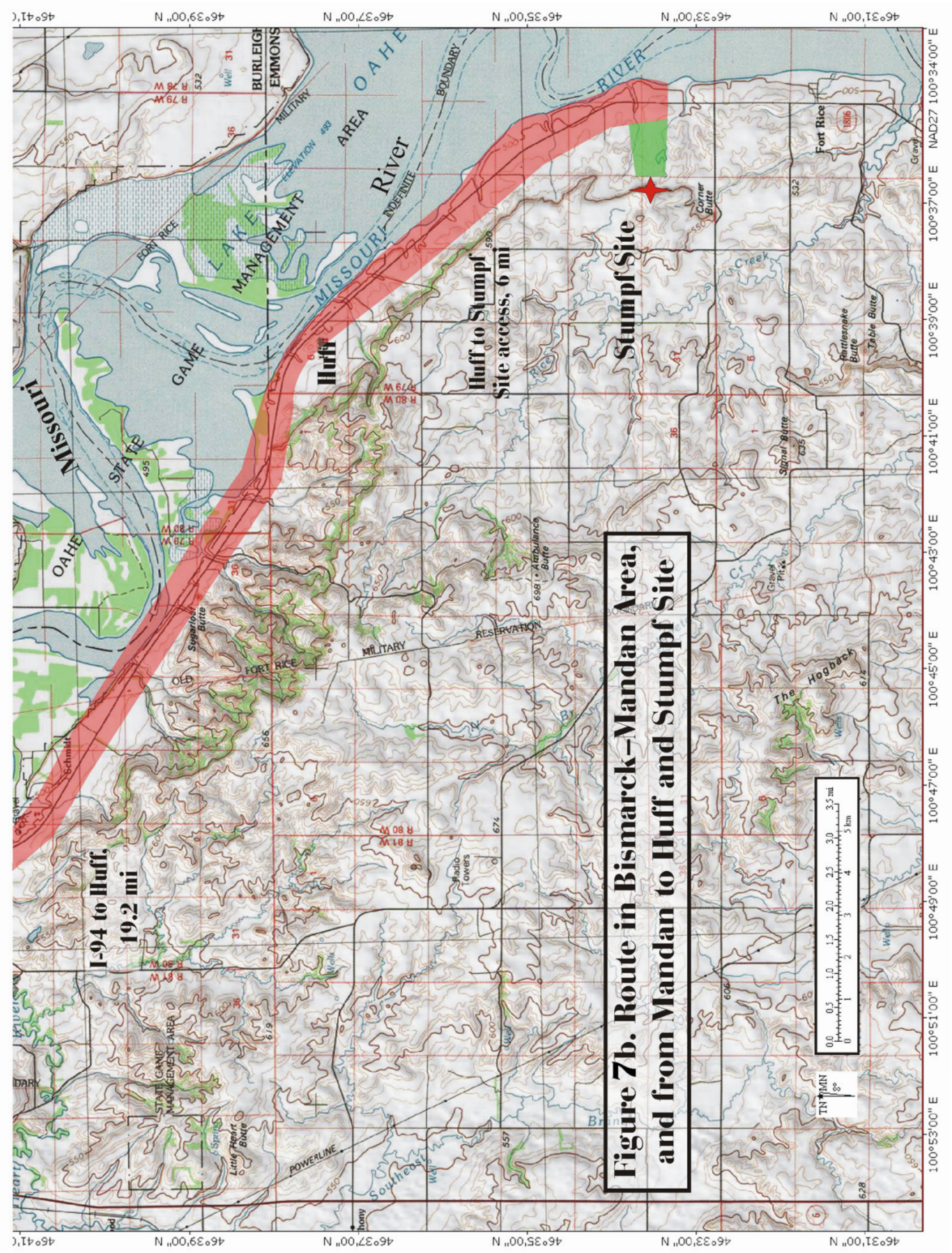


Figure 7a. Route in Bismarck–Mandan Area, and from Mandan to Huff and Stumpf Site
Fargo to Bismarck, 193 mi
Heritage Center
Bismarck
Bismarck to 1806 on I-94, 5.4 mi
Mandan
Missouri River
I-94 to Huff, 19.2 mi
FORT LINCOLN STATE PARK
OLD FORT LINCOLN MILITARY RESERVATION BOUNDARY
MORTON CO
BURLEIGH CO
Cottonwood Lake
Apple Valley
POWERLINE
BURLINGTON
NORTHERN
Municipal Airport
Mandan Muni Airport
Bismarck Jr College
Tank Farm
Radio Tower
Gaging Sta
Substation
Gravel Pits
Twin Buttes
Rest Area


Missouri
River
OAHE
AREA
LAKE
OAHE
MANAGEMENT
GAME
STATE
MISSOURI
RIVER
BOUNDARY
INDEFINITE
FORT RICE
MILITARY
RESERVATION
BURLEIGH
EMMONS
Huff
Huff to Stumpf
Site access, 6 mi
Stumpf Site
1-94 to Huff,
19.2 mi
Figure 7b. Route in Bismarck–Mandan Area,
and from Mandan to Huff and Stumpf Site
Fort Rice
Corner Butte
Rattlesnake Butte
Table Butte
Signal Butte
Ambulance Butte
Sugarloaf Butte
Hogback
Radio Towers
Little Heart Butte
POWERLINE
Creek
River
NAD27

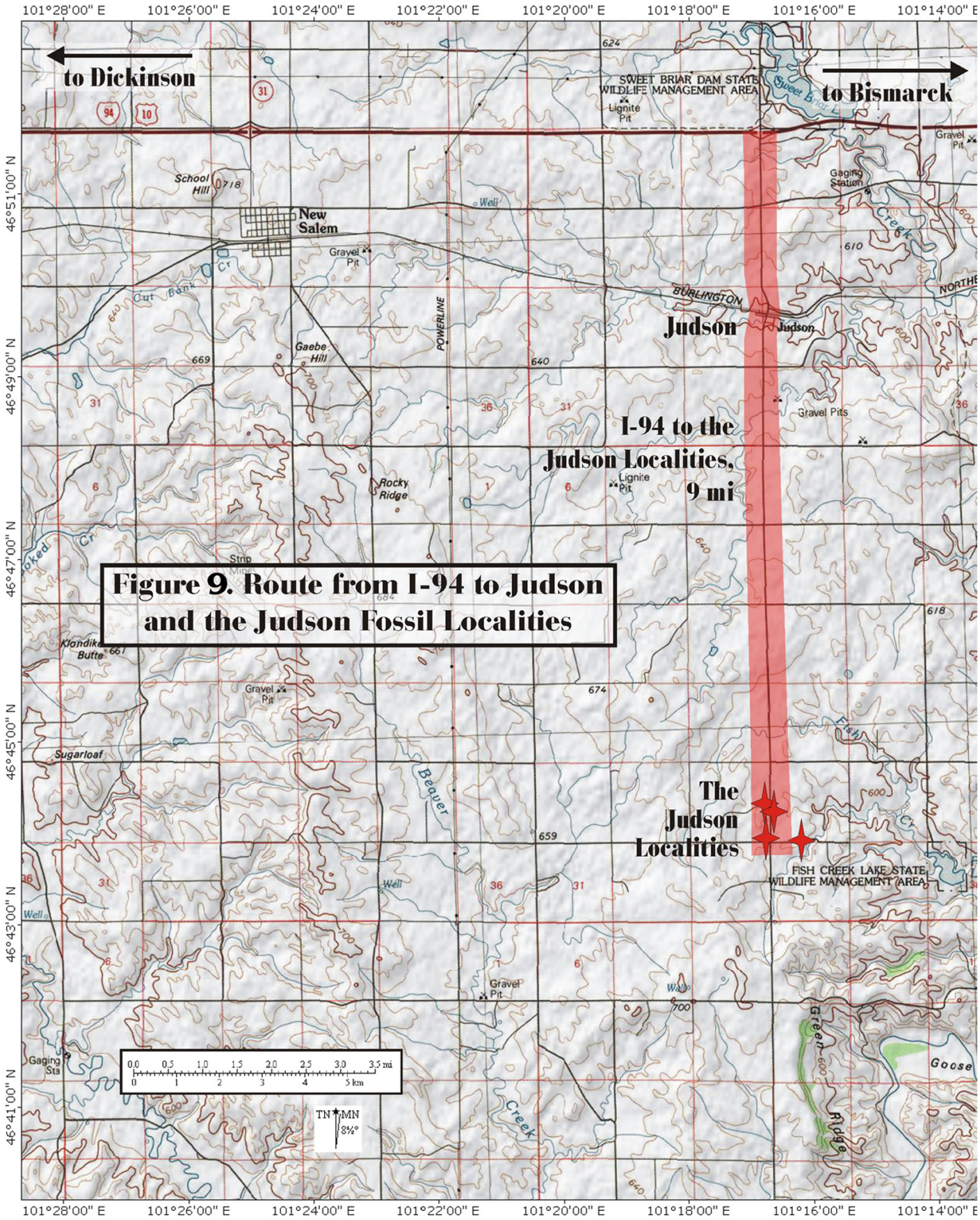


Figure 9. Route from I-94 to Judson and the Judson Fossil Localities

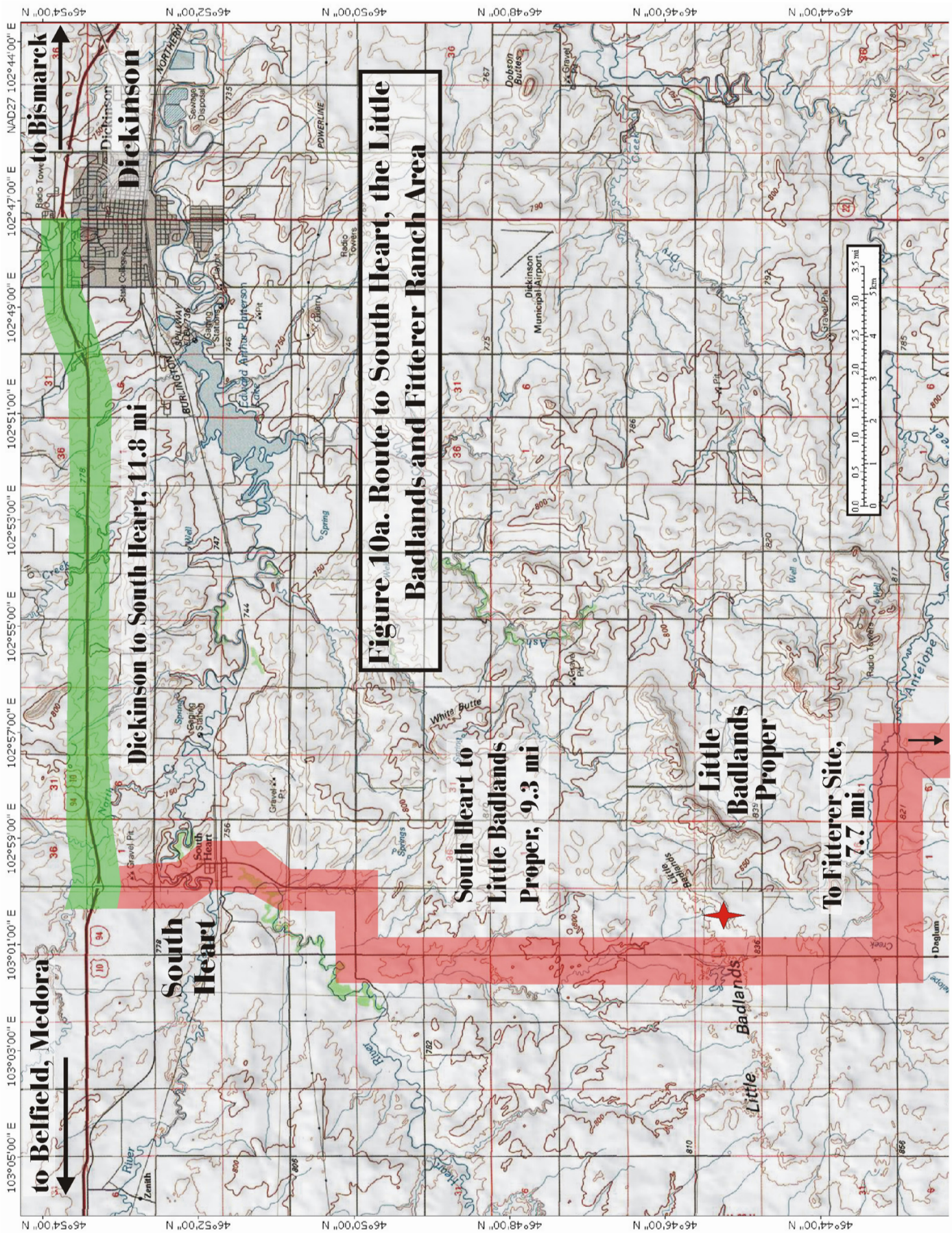
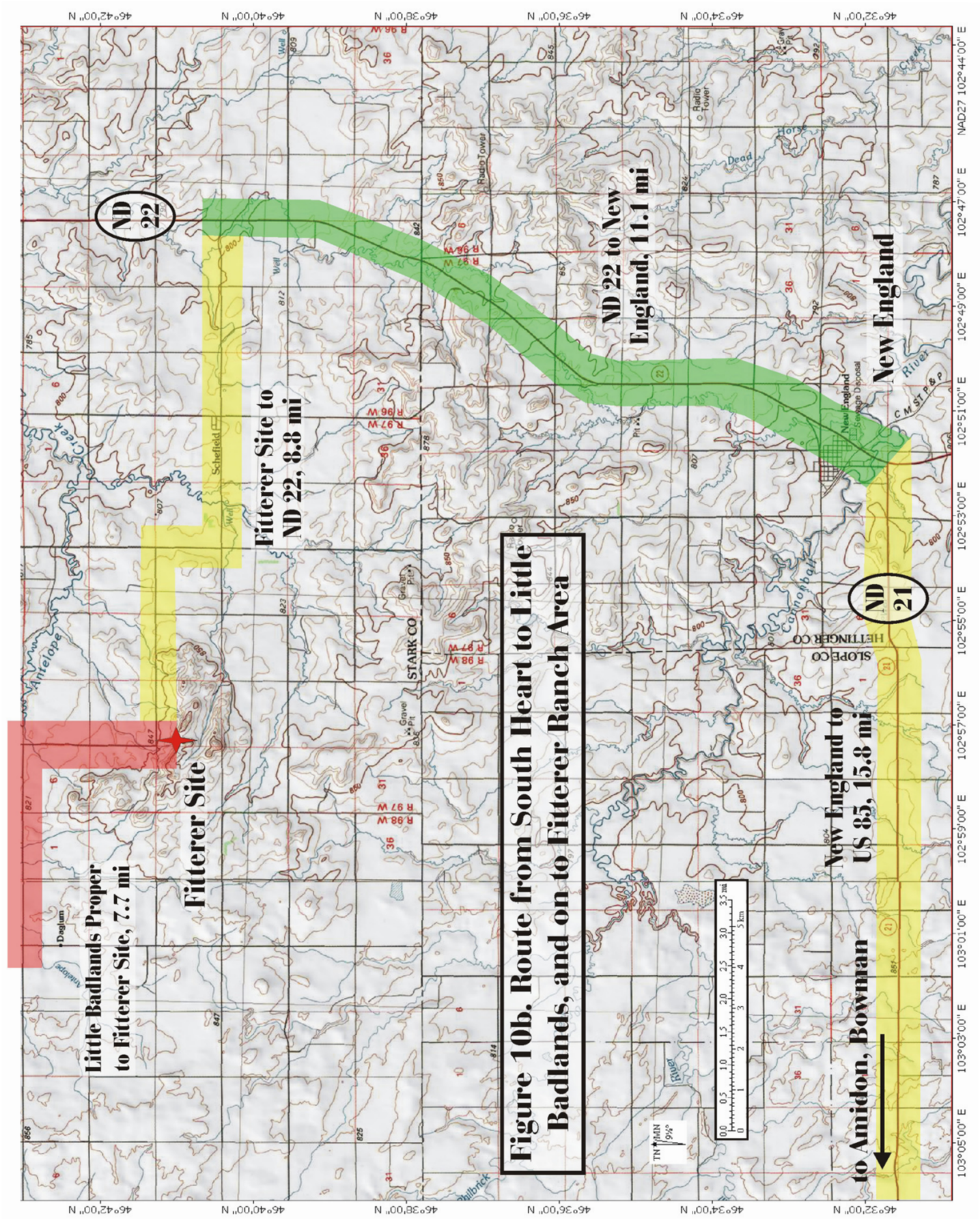
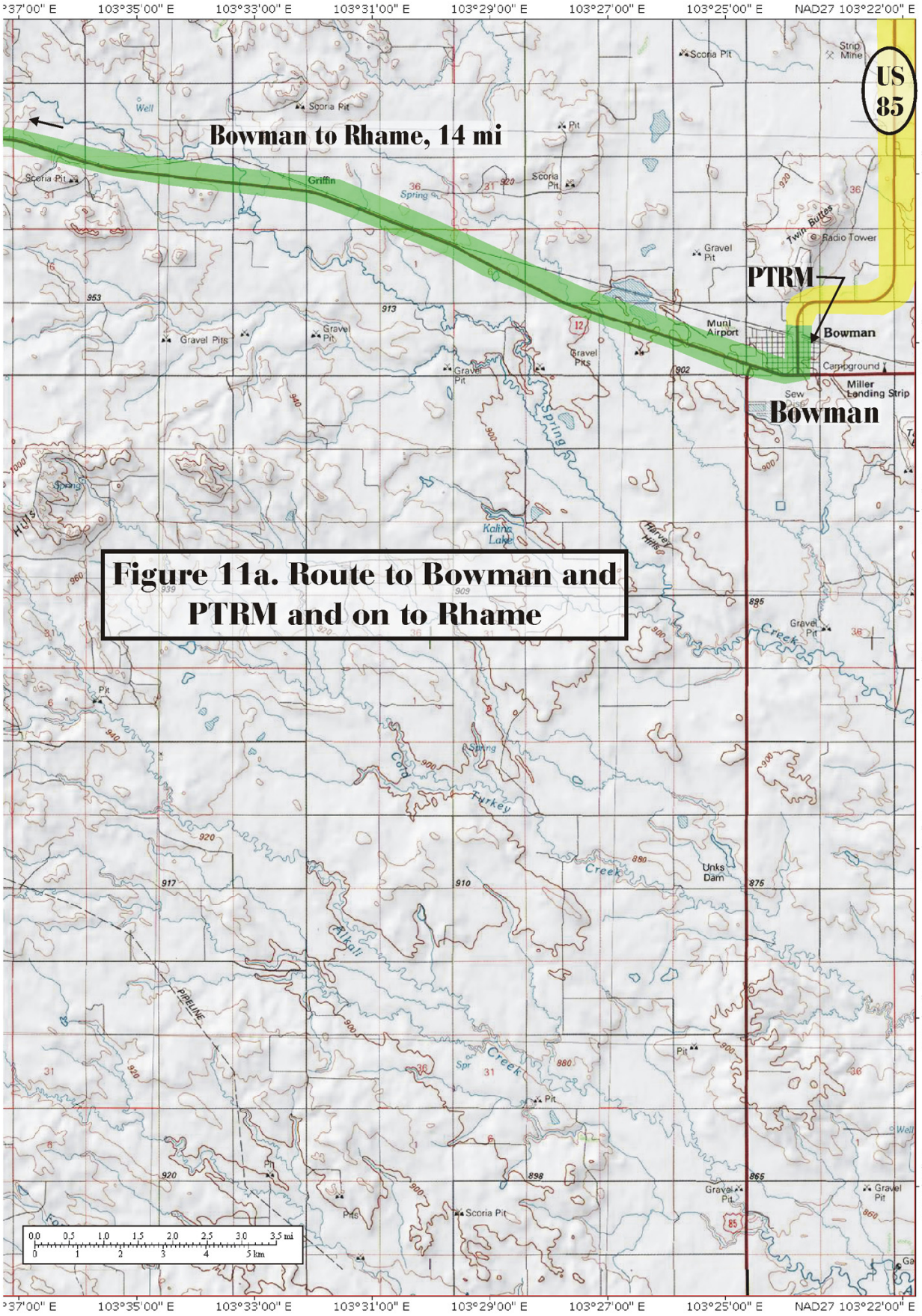
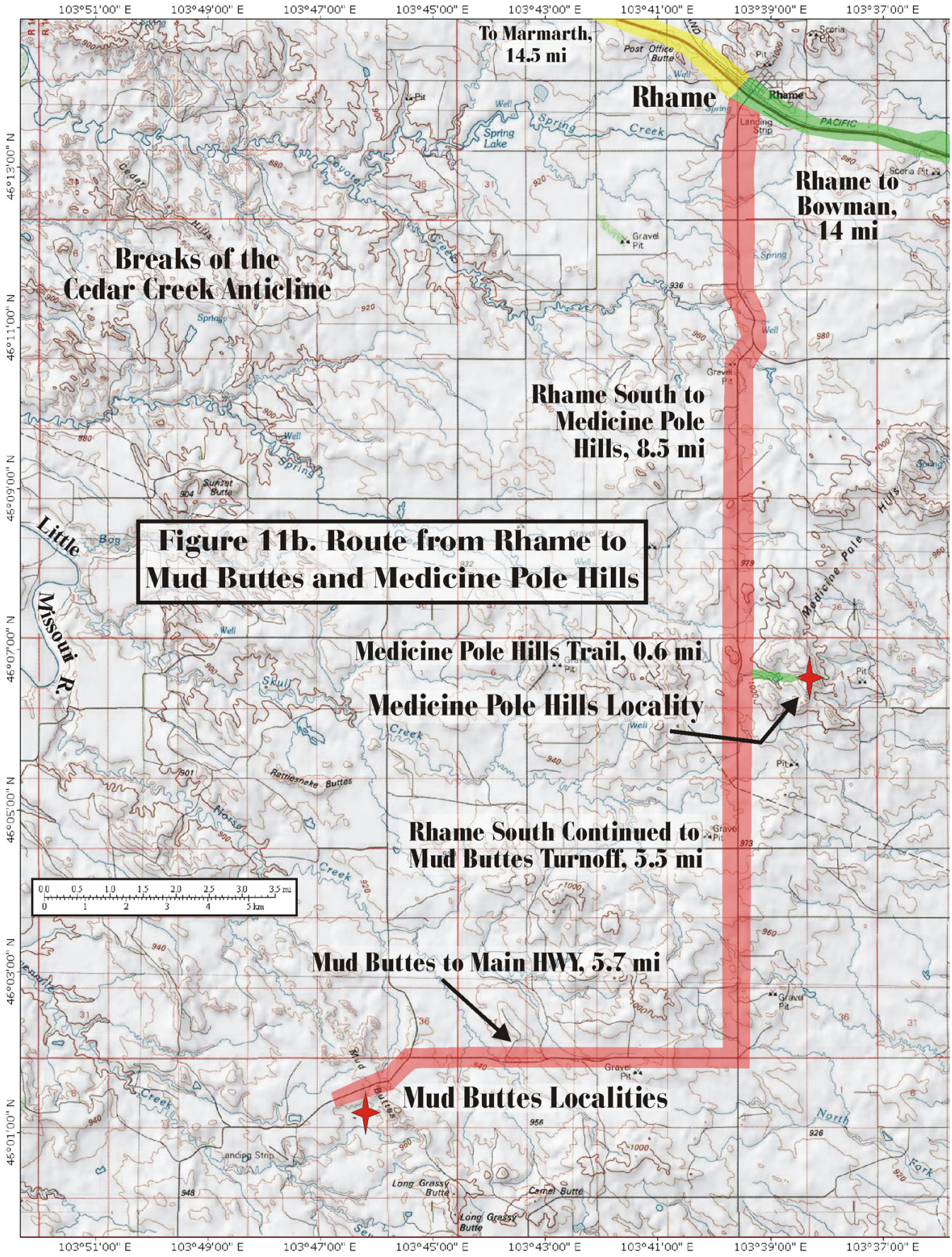


Figure 10a. Route to South Heart, the Little Badlands and Fitterer Ranch Area
to Bismarck
Dickinson
Dickinson to South Heart, 11.8 mi
South Heart
South Heart to Little Badlands Proper, 9.3 mi
Little Badlands Proper
To Fitterer Site, 7.7 mi
to Belfield, Medora


Little Badlands Proper
to Fitterer Site, 7.7 mi
Fitterer Site
Fitterer Site to
ND 22, 8.8 mi
ND 22 to New
England, 11.1 mi
New England to
US 85, 15.8 mi
to Amidon, Bowman
ND 22
ND 21
New England
STARK CO
SLOPE CO
HETTINGER CO
Antelope
Schefield
Deglum
Gravel Pit
Radio Tower
Well
Dead Horse
Cannonball
C M ST P & P
River
Figure 10b. Route from South Heart to Little
Badlands, and on to Fitterer Ranch Area


Bowman to Rhame, 14 mi
US 85
PTRM
Bowman
Figure 11a. Route to Bowman and PTRM and on to Rhame


To Marmarth, 14.5 mi
Rhame
Rhame to Bowman, 14 mi
Breaks of the Cedar Creek Anticline
Rhame South to Medicine Pole Hills, 8.5 mi
Figure 11b. Route from Rhame to Mud Buttes and Medicine Pole Hills
Medicine Pole Hills Trail, 0.6 mi
Medicine Pole Hills Locality
Rhame South Continued to Mud Buttes Turnoff, 5.5 mi
Mud Buttes to Main HWY, 5.7 mi
Mud Buttes Localities
Little Missouri R.
103°51'00" E
103°49'00" E
103°47'00" E
103°45'00" E
103°43'00" E
103°41'00" E
103°39'00" E
103°37'00" E
46°13'00" N
46°11'00" N
46°09'00" N
46°07'00" N
46°05'00" N
46°03'00" N
46°01'00" N

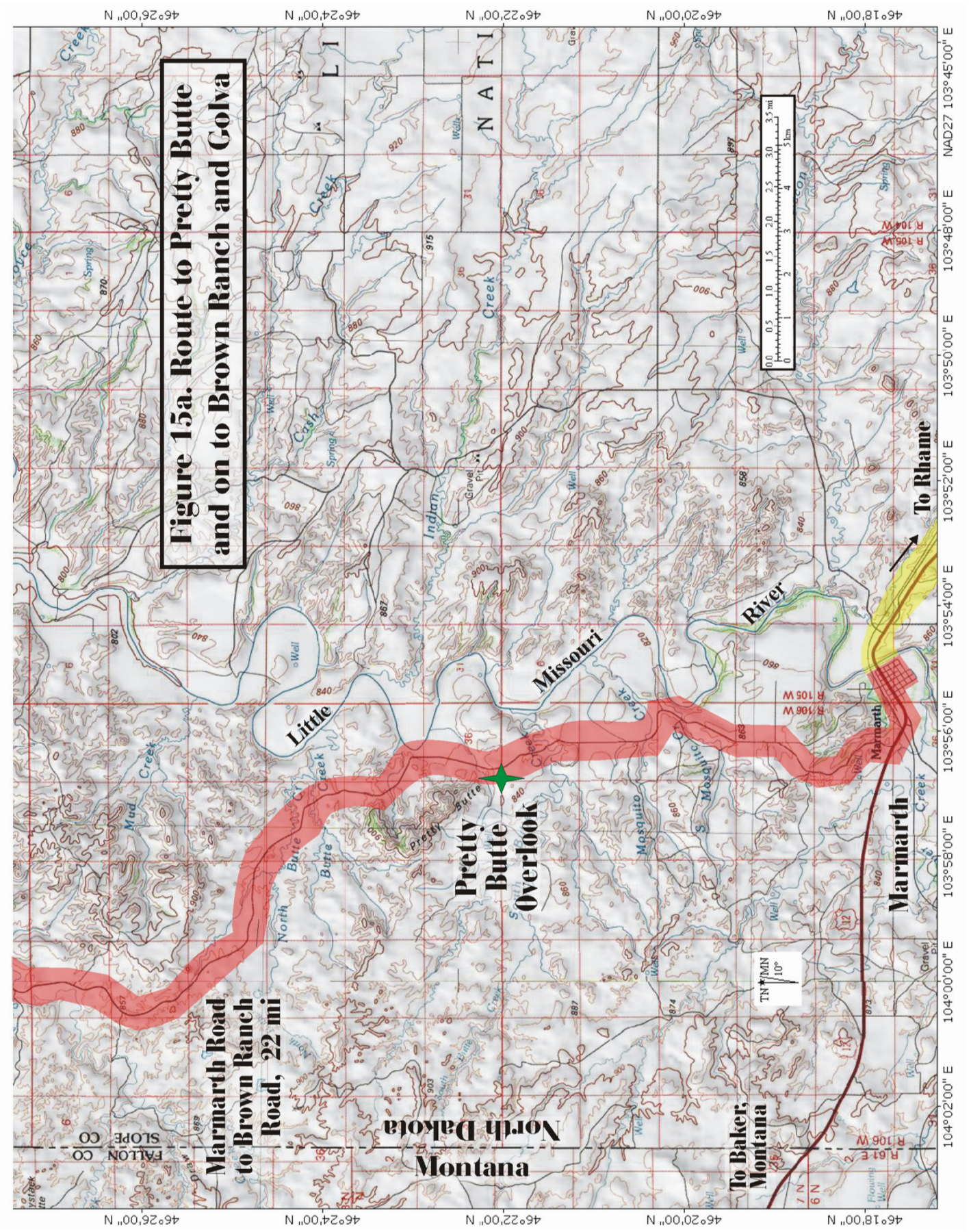


Figure 15a. Route to Pretty Butte and on to Brown Ranch and Golva
Marmarth Road, to Brown Ranch Road, 22 mi
Pretty Butte Overlook
Little Missouri River
Marmarth
To Rhame
To Baker, Montana
North Dakota
Montana
NATIONAL
46°26'00" N
46°24'00" N
46°22'00" N
46°20'00" N
46°18'00" N
104°02'00" E
104°00'00" E
103°58'00" E
103°56'00" E
103°54'00" E
103°52'00" E
103°50'00" E
103°48'00" E
103°45'00" E
NAD27

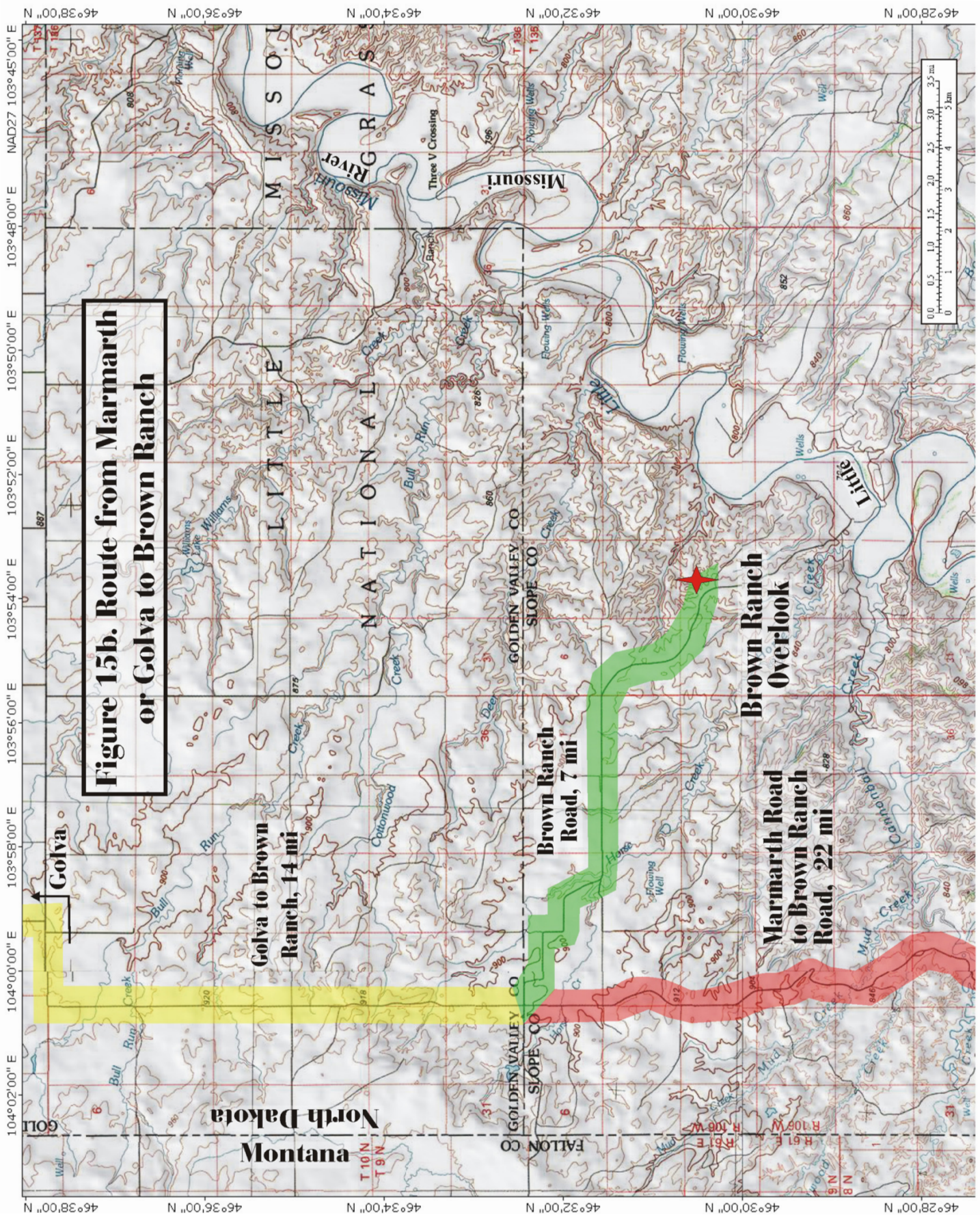


Figure 15b. Route from Marmarth or Golva to Brown Ranch
Golva
Golva to Brown Ranch, 14 mi
Brown Ranch Road, 7 mi
Marmarth Road to Brown Ranch Road, 22 mi
Brown Ranch Overlook
North Dakota
Montana
GOLDEN VALLEY CO
SLOPE CO
FALLON CO
LITTLE MISSOURI NATIONAL GRASSLAND
Missouri River
Three V Crossing
Little Missouri
Lake Williams
Cottonwood
Bull Run
Mud Creek
Horse Creek
Flowing Wells
NAD27 103°45'00" E
103°48'00" E
103°50'00" E
103°52'00" E
103°54'00" E
103°56'00" E
103°58'00" E
104°00'00" E
104°02'00" E
46°38'00" N
46°36'00" N
46°34'00" N
46°32'00" N
46°30'00" N
46°28'00" N